NOVEMBER/DECEMBER 2024

23PPH22 — QUANTUM MECHANICS - I

Time : Three hours Maximum : 75 marks

Shanmuga Industries Arts & Science College T.V.Malai

SECTION A — (10 × 2 = 20 marks)

Answer ALL questions.

1. What is stationary state?
2. Give two examples of Hermitian operators.
3. Define quantum mechanical tunnel effect.
4. What is zero-point energy of harmonic oscillator?
5. Distinguish between coordinate and momentum representations.
6. Why time reversal operator is not linear?
7. What do you mean by perturbation?
8. What is the principle of variation method?
9. Define spin angular momentum.
10. Write operators associated with angular momentum.

17. Write the schrodinger equation and the form of the wave function in the different regions of a square well with finite depth.

18. Can a wave function be represented as a matrix? Discuss the significance of Schrodinger, Heisenberg and interaction representation in matrix formulation.

19. Outline the principle of W.K.B. method to find the approximate solution of Schrodinger equation for particle of potential energy slowly varying.

20. Derive CG coefficients and interpret its significance.

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SECTION B — (5 × 5 = 25 marks)

Answer ALL questions.

11. (a) A wave function $\psi(x)$ is given by $\psi(x) = A_n Sin\left(\frac{2n\pi x}{L}\right)$ in the region $0 < x < L$. Find the value of A_n using normalization condition.

Or

(b) Write in detail about Heisenberg's uncertainty principle.

12. (a) What are Bloch functions? State and explain Bloch theorem.

Or

(b) A rigid rotator is constrained to rotate about a fixed axis, find out its normalized eigen values and eigen functions.

13. (a) Outline Dirac's bra and ket notation.

Or

(b) What do you mean by unitary transformations?

14. (a) Discuss time independent perturbation theory and obtain expressions for the first order correction to energy and Eigen function.

Or

(b) Use the variation method to evaluate the ground state energy of a particle in the potential, defined by $V = \begin{cases} \infty & for \quad x < 0 \\ kx & for \quad x > 0 \end{cases}$. Use xe^{-ax} as the trial wave function.

15. (a) If J_x, J_y, J_z are angular momentum operators, show that $[J_z, J_\pm] = \pm\hbar J_\pm$ where $J_+ = J_x + iJ_y$ and $J_- = J_x - iJ_y$.

Or

(b) What are symmetric and antisymmetric wave functions? Show how do they lead to the pauli's exclusion principle.

SECTION C — (3 × 10 = 30 marks)

Answer any THREE questions.

16. State and prove Ehrenfest's theorem and show how it leads to the correspondence principle.